

BIOLOGY AND SYSTEMATICS OF *GALAXIA* (IRIDACEAE)

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ABSTRACT

Galaxia is a small genus of Iridaceae-Iridoideae, endemic in the winter rainfall region of southern Africa. Twelve species in two subgenera are included in the genus, a marked increase in the previously recognized five species and one variety. Four species in this treatment, *G. barnardii*, *G. alata*, *G. luteo-alba* and *G. stagnalis* are new to science. Geographic speciation appears important in subgenus *Eurystigma* while ecological speciation is significant in subgenus *Galaxia*. Important evolutionary trends in *Galaxia* are aneuploid in chromosome number and development of autogamy.

UITTREKSEL

BIOLOGIE EN SYSTEMATIEK VAN *GALAXIA* (IRIDACEAE)

Galaxia is 'n klein genus van die Iridaceae-Iridoideae, wat endemies is in die winter reënval streek van Suid-Afrika. Twaalf spesies in twee subgenera word in die genus ingesluit, 'n groot vermeerdering van die vorige erkende vyf spesies en een variëteit. Vier spesies in hierdie hersiening, *G. barnardii*, *G. alata*, *G. luteo-alba* en *G. stagnalis* is nuut. Geografiese spesiasie skyn van betekenis te wees in die subgenus *Eurystigma* terwyl ekologiese spesiasie van belang is in subgenus *Galaxia*. Belangrike neigings in die evolusie van *Galaxia* is aneuploïde verandering van die chromosoomgetal en ontwikkeling van autogamie.

INTRODUCTION

Galaxia is a small genus of Iridaceae which is confined to the southern and western portions of the Cape Province of South Africa (Fig. 1), an area with a mediterranean climate. The genus consists exclusively of small, stemless plants of a *Crocus*-like habit, which produce a cluster of leaves and flowers near ground level. *Galaxia* was believed at one time to be allied to *Crocus*, *Romulea*, and *Syringodea*, genera with similar growth form, either constituting a separate subfamily Crocoideae (Pax, 1888) or a subtribe of Sisyrinchieae (Diels, 1930). However, following suggestions by Arber (1921) *Galaxia* has been shown to belong to subfamily Iridoideae (Lewis, 1954) and to be related to *Moraea* and *Homeria* (tribe Homeriinae) (Goldblatt, 1976b). The evolution of *Galaxia* thus parallels that of the similarly specialized *Crocus*, *Romulea* and *Syringodea*. *Galaxia* was described in 1782, yet has remained largely misunderstood until

today owing to paucity of collections and to difficulties in preserving the extremely fragile flowers. Twelve species are admitted in this treatment which represents a twofold increase in the number of taxa currently recognized in herbaria. Four new species are described in this paper, while three more are restored to recognition.

RELATIONSHIPS

The affinities of *Galaxia* were at one time believed to lie with *Crocus*, *Syringodea* and *Romulea* of subfamily Ixiodeae which, like *Galaxia*, comprise mostly stemless plants with small flowers borne at or near ground level. Pax (1888) even included these three similarly reduced genera in a single subfamily, Crocoideae. Arber (1921) pointed out the similarity in leaf anatomy of *Galaxia* to the Iridoideae, specifically to *Moraea*. Later, Lewis (1954) quite convincingly showed that *Galaxia* belonged to this subfamily, and to *Moraea* and its allies in particular by virtue of its leaf, corm and flower structure. This treatment was supported by myself (Goldblatt, 1971) on cytological grounds and by Schulze (1971) on the basis of pollen structure and *Galaxia* is now included in subtribe Homeriinae (Goldblatt, 1976b). This predominantly African grouping comprises *Moraea*, *Homeria*, *Hexaglottis*, *Barnardiella*, and *Gynandiris*, and *Galaxia* shares with these a secondarily bifacial leaf and characteristic corm. The corm in subtribe Homeriinae consists of a single swollen internode with a primordial apical bud at its apex. Roots emerge from the base of the apical bud when growth is initiated. This stands in marked contrast to the usual several internode corm of subfamily Ixiodeae, which includes *Crocus* and *Romulea*, where roots emerge from the corm base and not from the apical bud base. The corm in Ixiodeae is usually derived from the base of the flowering stalk (De Vos, 1977) though in a few genera from an axillary bud, while the corm of Homeriinae always develops from an axillary bud.

Cytologically *Galaxia* also accords with the Iridoideae and it has the usual large chromosomes of this subfamily (Goldblatt, 1971) in contrast with the generally small chromosomes of Ixiodeae (where *Crocus* is however a notable exception). *Galaxia*, with chromosome numbers of $n = 9, 8$ and 7 (Goldblatt, 1980) seems most closely related to *Moraea*, in which $x = 10$ is basic and lower numbers of $n = 9, 8$ and 6 occur (Goldblatt, 1976a). A derived base number of $x = 6$ occurs in other genera of Homeriinae, except *Barnardiella*, with $x = 10$.

Morphologically, *Galaxia* stands apart from other members of Homeriinae where it is the only genus which consistently has a perianth tube (a perianth tube is also found in two species of *Moraea* and one of *Hexaglottis*) and also in general habit. The inflorescence found in *Galaxia* with its sessile flowers is difficult to interpret but seems to be similar to the basic type in Homeriinae.

The reduced habit of *Galaxia* is matched in the four species of *Moraea* section *Acaules*. These species also lack an aerial stem and have leaves and

flowers borne at ground level. Section *Acaules*, with a base number of $x = 10$, includes *M. falcifolia* Klatt as well as the well-known *M. ciliata* (L.f.) Ker, but these species have pedicellate flowers in several-flowered inflorescences. Nevertheless, section *Acaules* is most likely the closest related group to *Galaxia*, and the two may well have had a common ancestor in some extinct species of *Moraea*.

GEOGRAPHY

Galaxia is restricted to the winter rainfall region of the Cape Province of South Africa and, in fact, occurs primarily in the Cape Floristic Region. Four species of *Galaxia* occur in central Namaqualand, north of the area usually included in the Cape Floristic Region. One of these, *G. fugacissima*, a Cape species extends locally almost as far north as Springbok and *G. ciliata* a



FIG. 1.

Range of *Galaxia* in South Africa. The interrupted line indicates the approximate limits of the winter rainfall region.

Namaqualand endemic, occurs between Nuwerus and Spektakelberg. This is considerably north of the area usually considered as comprising the Cape Floristic Region (Goldblatt, 1978) and well north of the Kamiesberg in southern Namaqualand which Weimarck recognizes as the northernmost limit of Cape Flora. At Spektakelberg *Galaxia* occurs amongst several typically Cape taxa and in a community that must be regarded as an outlier of the Cape Flora. Typical Cape taxa on the Spektakelberg include *Diosma acmaeophylla* (Rutaceae), *Cliffortia* (Rosaceae), *Struthiola* and *Passerina* (Thymelaeaceae), three species of *Lobostemon* (Boraginaceae), *Erica plukenetii*, *Restio sieberi*, and several Iridaceae that occur well to the south, some on the Cape Peninsula, including *Geissorhiza aspera*, *Ixia erubescens*, *Hexaglottis lewisiae*, *Moraea tenuis* and *M. ciliata*.

The total range of *Galaxia* (Fig. 1) extends southward from Spektakel Pass in Namaqualand, through the Kamiesberg to the western Cape, and into the southern Cape with the most eastern record from the Humansdorp district. With the exception of the Caledon area, the southern Cape is poor in species and the centre of the genus clearly lies to the west (Fig. 2). Species concentration is highest in the Worcester and Wuppertal grid squares (Fig. 2) with six species in each area. The Cape Town and Caledon grid squares have five species in each. Local areas of high species numbers are the northern Cape Peninsula, around Cape Town, where there are five species and the Cedarberg and Cold Bokkeveld where four species occur in close proximity.

ECOLOGY AND BIOLOGY

Habitat

The landscape of the southern and western Cape Province is considerably dissected, with high mountain ranges lying parallel to one another and to the coastline. There are thus a series of valleys and mountains from the coast to the interior, each progressively drier than the one nearer the coast. Valleys and lower mountain slopes generally have a clay soil derived from shale and the mountains a coarse sandy soil (Dahlgren, 1968; Goldblatt, 1976b, 1978a). Thus species that tend to be montane grow on sand while lowland species grow on clay soils. There are extensive deposits of alluvial sands along the west coast and there are accordingly some exceptions to this generalization.

Typically clay-loving species are *Galaxia versicolor*, *G. barnardii* and *G. variabilis* while *G. fugacissima* and *G. ovata* occur on clay only in the well-watered, southern part of their ranges. These species grow either in exposed sites with little other plant growth or in communities dominated by small ericoid-leaved shrubs of either coastal fynbos or renosterbosveld (Acocks, 1953). *Galaxia ciliata* grows on clay in a similar habitat in Namaqualand, where clay soils are uncommon, a fact probably accounting for the rarity of this species.

Species that prefer sandy soils either grow on the mountains or in lowland alluvial sand. Several montane species occupy a very characteristic habitat,

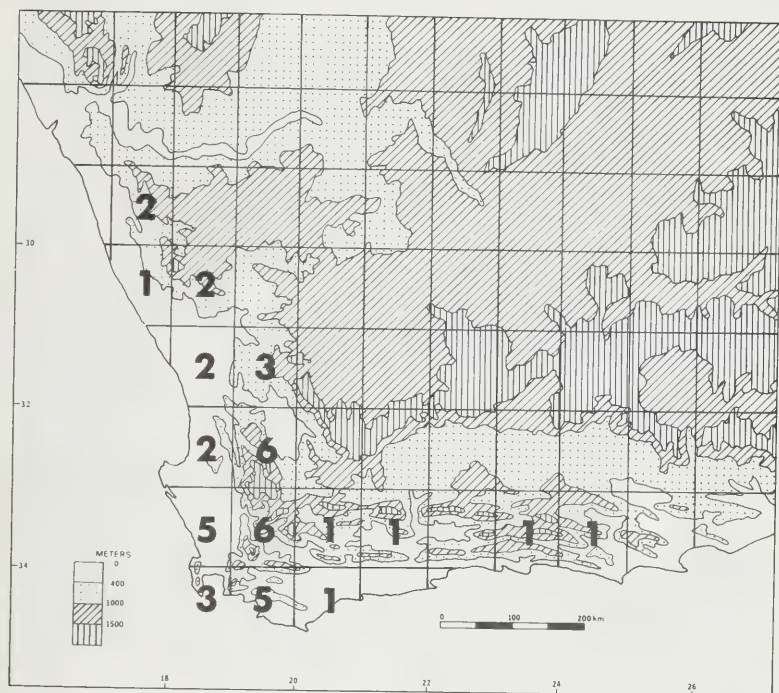


FIG. 2.

Species concentration of *Galaxia* given as number of species in each geographical one degree square.

namely very shallow soil on moist shelving slabs of rock, a situation where these small plants do not become crowded out and over-shadowed by the generally robust mountain vegetation. Species characteristic of these rocky seeps are *Galaxia luteo-alba*, *G. citrina*, occasionally *G. ovata* (often found in lowlands on clay soil) and sometimes *G. fugacissima*. *Galaxia stagnalis* may also be found on rock shelves, but only when these places are unusually wet, and more often this species grows in shallow temporary pools or in the bed of small seasonal streams.

Sand-loving species are also found in the open, but then mainly in seasonally very wet sites with poor drainage. Such places tend to have scanty vegetation and thus allow growing space for *Galaxia*. Species characteristic of this habitat are *Galaxia alata*, *G. grandiflora*, *G. fugacissima* and *G. albiflora*, the latter two sometimes growing together.

Floral Biology

The flowering rhythm in *Galaxia*, as in many other members of tribe Homeriinae, follows a strict pattern. Individual plants produce one or rarely two flowers at a time and each flower lasts a day only. Usually a few days elapse before a plant blooms again. Flowering is strongly synchronous in populations so that most plants flower on the same day and produce very few or no flowers on other days. Times of opening of flowers is constant for species, although somewhat influenced by external conditions such as temperature, and flowers open rapidly at particular times, and fade just as rapidly later in the day, when tepals very quickly collapse and deliquesce.

Flowers of subgenus *Galaxia* generally open in late morning, about 11h00, but earlier in *G. fugacissima*, at about 10h00, and fade at about 16h00. *Galaxia albiflora* is exceptional in opening only after 13h00 and fading shortly after 15h00. In subgenus *Eurystigma* flowers open from 11h00 to noon and fade between 16h00 and 16h30.

Observed insect visitors are small bees which are probably the most important pollinators for outcrossing species. The very bright coloured flowers are likely the major attractant for visitors, but a strong sweet scent is produced in *Galaxia fugacissima*.

As determined by greenhouse experiments, most species are self-incompatible, the rule in the southern African Iridoideae. Three important exceptions are *Galaxia albiflora*, *G. stagnalis* and some southern populations of *G. fugacissima*, all subgenus *Galaxia*. In these species parts of the fringed stigma are in contact with the anthers, and self-pollination and autogamy regularly occur. *Galaxia fugacissima* is of interest as some populations are pseudo-heterostylous. Some individuals have short styles and are autogamous while others with long styles and often shortened filaments are not autogamous (whether these are self-compatible or not is unknown). It is not known whether *G. ciliata* or *G. grandiflora* are self-incompatible or not.

HYBRIDIZATION STUDIES

Interspecific hybrids can be produced with comparative ease within subgenera but naturally occurring hybrids are rare, having been observed only between *Galaxia fugacissima* and *G. albiflora* and between *G. variabilis* and *G. citrina*. Triploid individuals ($2n = 27$) found amongst plants of *G. ovata* ($2n = 36$) and *G. alata* ($2n = 18$) growing together may also be natural hybrids, though these triploids strongly resemble *G. alata*.

Several artificial hybrids have been produced between all four species of subgenus *Eurystigma* and differences in chromosome number and karyotype between the four species of the subgenus appear not to affect ability to hybridize. The only cross not yet attempted is between *G. versicolor* and *G. variabilis*. All other possible crosses have been made and most have succeeded, exceptions being

G. variabilis $\times$ *G. citrina* and *G. barnardii* $\times$ *G. citrina* (in both the reciprocal crosses were successful). The results of these hybridization studies tend to confirm the close relationships of the four species of subgenus *Eurystigma*. Crosses between subgenera have so far all failed.

Only a few hybridization attempts have been made between species of subgenus *Galaxia*, as plants available did not produce sufficient flowers. Crosses between *Galaxia fugacissima* $\times$ *G. albiflora* succeeded, confirming observations in the field.

CHROMOSOME CYTOLOGY

Cytology of *Galaxia* has formed an important adjunct to the systematic study of the genus and is reported in detail separately (Goldblatt, 1980). Contrary to previously published data (Goldblatt, 1971) $n = 9$ is probably basic in the genus, not $n = 8$. Some counts for *Galaxia* which I published earlier were incorrect and led to the erroneous assumption that $n = 8$ was basic for *Galaxia*. All species of subgenus *Galaxia* in fact have $x = 9$, with polyploidy recorded in three of the eight species, *G. ovata*, *G. stagnalis*, and *G. alata*. In subgenus *Eurystigma* there is an unusual amount of chromosomal variation with $n = 8$ in *G. barnardii*, *G. citrina* and *G. versicolor*, both of the latter having some populations with $n = 7$. *G. variabilis* consistently has $n = 7$, and has a quite different karyotype from forms of *G. versicolor* with $n = 7$. Chromosome numbers are given in species descriptions, but documentation and descriptions of karyotypes are given elsewhere (Goldblatt, 1980), and are not repeated.

SPECIATION

The four species of subgenus *Eurystigma* have separate or almost separate geographical ranges (Figs 3, 6) and appear to have evolved from a common ancestral stock in isolation from one another. Three in particular, *Galaxia barnardii*, *G. versicolor* and *G. variabilis*, seem to be vicarious species which grow in similar ecological situations in their different ranges. The fourth species of the subgenus, *G. citrina*, is clearly very closely related to *G. variabilis*, but the two have different chromosome numbers and separate ecological requirements and although their ranges overlap to a small extent they seldom grow together. Hybrids have, however, been noted between these two species at three sites. Differences in chromosome number and in ecology are the probable isolating mechanisms which keep the two species distinct.

Species of subgenus *Galaxia* in contrast are often sympatric and frequently at least two species grow in the same general area. Each species of the subgenus however seem to have subtly different ecological preferences. Floral morphology is usually identical and hybridization may occur. Recorded hybrids between *G. fugacissima* and *G. albiflora*, both $n = 9$, are sterile, as are suspected hybrids

between *G. alata*, $n = 9$ and *G. ovata*, $n = 18$. Ecological speciation is implied in the subgenus, with hybrids that occur between different species growing near one another sterile either by virtue of the different ploidy levels of the parents, or for other unknown reasons.

The two smallest flowered species of subgenus *Galaxia*, *G. albiflora* and *G. stagnalis* are autogamous and would appear to have evolved recently. *G. albiflora* is strictly coastal in distribution, growing mainly on recent alluvial sands while *G. stagnalis* grows in the ecologically specialized habitat of vernal pools and seeps in the northern Cedarberg, and it is one of the earliest blooming species of the genus.

HISTORY OF *GALAXIA*

Although *Galaxia* has been known since the later Linnaean period, it has remained very poorly understood. When the genus was described by Thunberg in 1782, two species were already known, both having been sent to Linnaeus from the Cape the previous decade. The two species were, however, published only after Linnaeus' death, when his son (Linnaeus fil., 1781), described *Ixia galaxia* from a Sparrman collection and *I. fugacissima* from a Thunberg collection. The following year Thunberg described the genus *Galaxia*, recognizing the same two species but under different names with *Ixia galaxia* as *G. ovata* and *I. fugacissima* by the new name, *G. graminea*, the latter superfluous and therefore illegitimate. In fact, Thunberg knew a third species, the pink-flowered *G. versicolor*, which, like the previous two grew on the Cape Peninsula, but he included broader- and narrower-leaved forms of this species separately as var. *corollis violaceis* under *G. ovata* and *G. graminea* respectively.

Subsequent collecting in the Cape during the late eighteenth and early nineteenth centuries resulted in the discovery of several more species. Many of these new collections were clearly cultivated in Europe, a fact known from the excellent illustrations published by Jacquin in the *Icones Plantarum Rariorum* in 1795, by Ker in *Curtis's Botanical Magazine* from 1800 to 1812 and by Andrews in the *Botanists Repository* in 1800 and 1801. In spite of the availability of living plants and good published illustrations, *Galaxia* was misunderstood at this period. Jacquin's illustration in *Icones Plantarum*, tab. 291 includes three plants, all referred to as *G. ovata* although only one, the yellow-flowered plant, represents this species. The other two are forms of the species later named *G. versicolor*. Salisbury (1812) recognized the two remaining plants figured by Jacquin as different from *G. ovata* and he assigned each a different name; neither, however, was described and thus *G. mucronularis* and *G. versicolor* of Salisbury are nomina nuda. Klatt validated one of Salisbury's names, *G. versicolor*, in 1863. This same taxon was validly described by Ker in 1812 as *G. ovata* var. *purpurea*, which Klatt raised to specific level in 1882, evidently believing *G. versicolor* and *G. purpurea* to be distinct. Other species described during the period were *G.*

grandiflora Andr. and *G. ciliata* Pers. both from good illustrations of these taxa, and *G. multiflora* Spreng, which is not distinguishable from *G. ovata*.

Understanding of *Galaxia* remained poor throughout the nineteenth century. As treated by Baker (1892, 1896) in his *Handbook of the Irideae* and in *Flora Capensis*, two major treatments of Iridaceae produced in the 1890's, *Galaxia* was recognized as comprising only two species, *G. fugacissima* and *G. ovata*. Baker did in addition admit two varieties of *G. ovata*, var. *versicolor* and var. *ecklonii* (both *G. versicolor*).

The South African botanist and specialist in Iridaceae, G. J. Lewis, discovered and described three more species in the period 1935–1945, namely *G. albiflora*, *G. variabilis*, and *G. citrina*. Lewis (1950) continued to recognize *G. versicolor* as a variety of *G. ovata* so that although in fact eight of the 12 species of *Galaxia* admitted in this treatment were known by the mid-twentieth century, only five species and a variety are currently recognized in herbaria.

MORPHOLOGY

Rootstock

The rootstock is a corm of the *Moraea* type (Goldblatt, 1976b) consisting of a single swollen internode with a primordial bud at its apex. Corms of species of *Galaxia* are generally small, and usually less than 7 mm in diameter. The tunics covering the corms may however accumulate from year to year so that the corm can appear much larger.

Tunics of most species are similar, consisting of concentric layers with prominent dark brown vertical ridges, often woody in texture alternating with lighter coloured grooves of fine fibres sometimes covered by a slightly sticky exudate. As the tunics age, the layers begin to disintegrate, forming a loose and progressively more fibrous network. Corms of *Galaxia ciliata* stand out, as tunic layers of previous years tend to accumulate and form particularly large fibrous masses, losing all vestige of their original ridged structure.

The only other corm type found in *Galaxia* is that of *G. alata*, which has a spindle-shaped corm with a tunic of pale, bone-like material, in which there is no trace of fibres. The tunics are prominently winged rather than ribbed as in other species (Fig. 11).

Vegetative reproduction frequently occurs by formation of small cormlets around the main corm which produce separate plants in the following year. Cormlets are also sometimes produced in the axils of floral bracts if fertilization of the flower fails to occur. This phenomenon, first noted by Sprengel (1820) when he described *G. multiflora*, has been observed in the wild in *G. ovata* and *G. alata* and in the greenhouse for several more species including *G. fugacissima*, *G. variabilis*, *G. versicolor*, and rarely in *G. stagnalis* (which is generally autogamous).

Foliar Structures

Cataphylls: These envelop the underground part of the stem and are transparent and entirely sheathing. Occasionally the uppermost cataphyll may become green and even extended and with a free apex. In this case it is essentially a basal leaf. However, this does not happen regularly and seems to have no taxonomic significance.

Leaves: Basal leaves inserted below ground are not found in *Galaxia* except occasionally when a cataphyll becomes leaf-like. The true leaves are produced in a cluster at the stem apex, and surrounding the floral bracts. Leaves and outer floral bracts are in fact barely distinguishable except by position relative to a flower, though the leaves are generally larger.

The leaves are typically bifacial, fairly short and channelled, with an obtuse, apiculate apex. *Galaxia ovata*, and its allies *G. lutea-alba*, *G. stagnalis*, *G. ciliata* and *G. grandiflora* have particularly short leaves that are flat or only slightly channelled, and in the two first mentioned species the true leaves are ovate and prostrate.

A second important leaf type is found in *Galaxia fugacissima* where the distal part of the leaves and outer bracts is unifacial, sometimes for half the total length. Unusual leaves are found in *G. alata*. Here the leaf is terete in the distal half and often somewhat succulent.

The leaf margin is generally minutely ciliate and often visibly thickened and hyaline, which is particularly noticeable in *Galaxia ovata* and *G. luteo-alba*. In *G. luteo-alba* the cilia are very long, and in *G. ciliata* the leaf margins are almost villous. Cilia are distributed in a single row in all but *G. ovata* where they may either be uniseriate or densely and randomly arranged.

Inflorescence

The typical inflorescence of the Iridoideae is a corymbose cyme enclosed by two opposed bract-like spathes from which the flowers are produced serially borne on long pedicels. The situation in *Galaxia* does not conform to this general pattern, and the true relationship of the inflorescence here to the probable ancestral condition is obscure. Each flower in *Galaxia* is enclosed by two bract-like structures, an inner, transparent membranous bract entirely enclosed by a much larger leaf-like bract. These two together may represent the opposed spathes of other Iridoid genera, or a single spathe and a true bract. It seems, however, unnecessary to try and relate the inflorescence terminology of other Iridoideae to *Galaxia*. Instead I prefer not to give the inflorescence a formal name, and will simply regard the foliar structures subtending the flower as bracts whether leaf-like or not.

The Flower

The flower is similar in form in most species, is shortly stalked and consists of a well-developed perianth tube, the function of which is to raise the flower above

the leaves, and six spreading tepals. The tube itself is funnel-shaped in all but *Galaxia barnardii* where the tepals spread horizontally from a cylindrical tube. The tepals are subequal in size or those corresponding to the outer whorl may be slightly larger, but similar in shape.

All species of subgenus *Galaxia*, except *G. albiflora* and some individuals of *G. alata*, have flowers of a similar size and yellow colour, *G. grandiflora* standing out as somewhat larger. The bicoloured white and yellow flowers of *G. albiflora* are by far the smallest in the genus and when fully open, are about 20 mm across with individual tepals ± 10 mm long. *Galaxia alata* is the only species of this subgenus in which both yellow or white flowers occur, though yellow is more common.

Flower colour is more varied in subgenus *Eurystigma*, being pink-purple with a yellow and dark centre in *G. versicolor* and purple with an almost black centre in *G. barnardii*. *Galaxia citrina* has yellow flowers occasionally with black markings in the throat, while *G. variabilis* may have pink, yellow, orange or white flowers, with a yellow centre.

Androeceum

The filaments are inserted at the apex of the narrow part of the perianth tube and united either entirely or for most of their length except in *Galaxia luteo-alba*, which stands out in having spreading filaments united only at their base. In other species of subgenus *Galaxia* the filament tube is cylindrical and complete, with anthers sessile on the filament tube or the filaments may be free for ± 1 mm, as in some forms of *G. fugacissima* and in *G. stagnalis*. In subgenus *Eurystigma* the anthers are essentially sessile on the filament tube in *G. variabilis* and *G. citrina*, but quite conspicuously stalked in *G. versicolor* and *G. barnardii* where the free parts of the filaments curve outwards. The filament tube in these last two species is unusual in being somewhat swollen shortly above the slender base.

The anthers are typical of all Irideae in being linear-oblong, extrorse and loculicidal. Dehiscence occurs shortly after the flower opens and pollen remains in place until disturbed by an insect visitor. In *Galaxia albiflora*, the short-styled forms of *G. fugacissima* and *G. stagnalis*, the stigma is in direct contact with the anther and in these species only does self-pollination occur.

Gynoeceum

The ovary is similar in all species, being small and barrel-shaped. It is entirely enclosed by the membranous inner bract. The filiform style extends the length of the perianth and filament tubes, and divides above or at the level of the anthers into three very short branches. Each style branch expands to form the broad stigma lobe. In most species the stigma is horizontal, and the radial margins curve upward to stand $\pm$ erect.

The stigmas vary substantially in the two subgenera, being irregularly fringed (fimbriate) in subgenus *Galaxia*, and entire in subgenus *Eurystigma*. In the latter the style branches are sometimes held together laterally by delicate membranous connections, but more often are quite free. In newly-opened flowers the stigma lobe is often upright and appressed to the erect radial margins, gradually opening horizontally.

Fruits and Seeds

There is little difference in the capsular fruits of *Galaxia* species. Ripe capsules are generally 7–9 mm long and ovoid, and somewhat truncate at the apex. The seeds are numerous and dark, and angular to irregularly rounded.

SUBGENERIC CLASSIFICATION

Species of *Galaxia* fall into two clearly defined groups to which subgeneric status has been assigned. The first, subgenus *Galaxia* includes all the species with fringed stigmas (Fig. 10) and obsolete stigma crests. All eight species of the subgenus have yellow or white flowers. Basic chromosome number is $x = 9$ (Goldblatt, 1980) and most species are diploid. *Galaxia stagnalis* and most populations of *G. ovata* are tetraploid, $2n = 36$, while a population of *G. alata* is triploid, $2n = 27$.

The remaining four species of the genus are assigned to subgenus *Eurystigma*. In this group the stigmas are entire, and the crests often distinct. *Galaxia citrina* has yellow flowers, and the other species have either red, purple or bluish flowers, often with a yellow throat. Base number in subgenus *Eurystigma* is $x = 8$, but *G. citrina* and *G. versicolor* are heteroploid, with some populations having $n = 7$. *Galaxia variabilis* has a diploid number of $2n = 14$.

SYSTEMATICS

GALAXIA Thunberg, Nov. Gen. 50. 1782; Ker, Irid. Gen.: 70. 1827; Baker, Handbook Irid: 96. 1892 et Flora Cap. 6: 32. 1896. Type species: *Galaxia ovata* Thunb. (lectotype).

Plants small with leaves and inflorescences forming a fascicle $\pm$ at ground level. *Corms* small and surrounded by entire or fibrous tunics usually with prominent vertical ridges, extending shortly upwards and frequently tapering to a point below. *Cataphylls* 2–3, transparent, sheathing underground part of stem, uppermost generally extending slightly above ground and green-tipped. *Leaves* clustered at stem apex; bifacial entirely, or distally unifacial or terete; ovate-oblong to linear, spreading or erect; occasionally a basal leaf is produced. *Stem* entirely subterranean or produced shortly above ground, but elongating in fruit. *Flowers* few to several, clustered together amongst the leaves and individually subtended by an inner membranous bract and an outer leaf-like bract; *perianth*

tube well developed, raising the flower above the leaves; *tepals* $\pm$ equal and spreading; yellow, white or shades of pink to purple. *Filaments* inserted at the throat of the tube, partly to entirely united (joined at base only in one species); *anthers* oblong. *Style* slender and usually erect (declinate in one species), produced above anthers and with three short branches opposite the anthers; *style branches* apically stigmatic and fringed or entire, with radial margins minutely raised above the stigma. *Ovary* $\pm$ sessile, ovoid, green. *Capsule* dry, sub-membranous, ovoid; *seeds* many, small, angled. *Basic chromosome number* $x = 9$, other gametic numbers $n = 18, 17, 8, 7$.

Type Species: Galaxia ovata Thunb. (lectotype).

Distribution: South Africa, Cape Province, concentrated in the southwestern Cape and extending north into Namaqualand; only in areas of mediterranean climate (Figure 1).

KEY TO THE SPECIES

- 1 Corm tunics entire, bony not fibrous, with prominent vertical wings; leaves terete distally, grooved in lower half only 11. *G. alata*
- Corm tunics fibrous, reticulate often with prominent vertical ribs and cross fibres fine, occasionally obscure; leaves channelled, flat, or unifacial 2
- 2 Cilia on hyaline leaf border at least $2\frac{1}{2} \times$ longer than width of border 3
- Cilia of leaf border minute, $\pm$ equal to width of border, or border smooth 4
- 3 Lowermost leaves prostrate, flat; filaments free in upper 2/3; Cedarberg to Nieuwoudtville 7. *G. luteo-alba*
- Lowermost leaves ascending or falcate (rarely prostrate), channelled; filaments entirely united; Namaqualand. 6. *G. ciliata*
- 4 Flowers white and tepals 9–11 mm long; style not reaching apex of anthers 12. *G. albiflora*
- Flowers shades of yellow, pink, purple, rarely white, and if so tepals at least 20 mm long; style usually exceeding the anthers 5
- 5 Stigma margin irregularly fringed; flowers yellow 6
- Stigma margin entire; flowers completely yellow or shades of red to purple (or white) with or without yellow centre 10
- 6 Outermost leaves ovate, obtuse, flat and prostrate; margin straight with border densely covered with cilia or cilia arranged in a single row 8. *G. ovata*
- Outermost leaves linear, lanceolate or oblong, acute or obtuse, channelled or occasionally flat, erect, falcate, occasionally prostrate; margin straight or undulate-crisped, border cilia if present never densely covering border 7
- 7 Leaves linear, or narrowly lanceolate, unifacial distally, erect to falcate 10. *G. fugacissima*
- Leaves entirely bifacial or unifacial only at apex 8
- 8 Leaves obtuse, channelled, falcate, and more than 4 mm wide, tepals 22–30 mm long 5. *G. grandiflora*
- Leaves obtuse or acute, straight, erect or spreading, channelled, and less than 3 mm wide, tepals less than 16 mm long 9
- 9 Plants occurring from the northern Cedarberg to Namaqualand in sand, wet places 9. *G. stagnalis*
- Plants occurring from the Caledon district eastwards, often on clay 10. *G. fugacissima*

- 10 Anthers sessile on filament column (or with free part of filament no more than 0,5 mm) and anthers straight 11
 — Anthers stalked for at least 1 mm, free part of filaments diverging and anthers arcuate 12
 11 Flowers yellow; tepals 18–23(–30) mm long, rarely wider than 10 mm; filament column cylindrical 4. *G. citrina*
 — Flowers shades of orange, pink to blue-purple (or white) with yellow throat; tepals 20–35 mm long, usually wider than 10 mm; filament column dilated in lower part 3. *G. variabilis*
 12 Style extending well beyond anthers; tepals cupped and only upper part spreading; anthers usually 1,5–2,5 mm, rarely to 4 mm long 2. *G. versicolor*
 — Style dividing at level of anthers, either not reaching apex of anthers or only slightly longer; tepals not cupped, spread horizontally from the base, anthers 3–3,5 mm long 1. *G. barnardii*

1. SUBGENUS EURYSTIGMA

Subgenus *Eurystigma* Goldbl., subg. nov.

Type species: Galaxia versicolor Salisb. ex Klatt.

A subgenus *Galaxia* differt stigmatis integris, lobatis, foliis magnis, canaliculatis et floribus grandioribus saepe percoloratis.

Leaves bifacial, channelled, erect or sometimes becoming prostrate. Flowers often large, yellow or usually pink, red, or purple. Stigmas entire, lobed; radial margins erect, distinct. Chromosome numbers $n = 8, 7$.

Distribution: southwestern Cape between Nieuwoudtville and the Caledon district.

1. *Galaxia barnardii* Goldbl., sp. nov.

Tunicae corni brunneae, fibris cancellatis, costis crassis lignosis. Folia bifacialia canaliculata, 40–60 mm longa, undulata, marginibus saepe crispis, hyalinis, ciliatis. Flores bubalini-purpurei, nigrescentes ad centrum; tubus perianthii 13–30 mm longus; tepala 15–25 mm longa, patentia. Filamenta 4–6,5 mm longa; antherae 3,0–3,5 mm, arcuatae. Stigmata integra, lata.

Type: SOUTH AFRICA, Cape, clay slopes between Eseljag and Queen Anne, Caledon district, *Goldblatt* 2499 (MO, holotype; BOL, K, NBG, PRE, S, WAG, isotypes). **Fig. 3.**

Plants solitary or growing in clumps. *Corm* tunics of brown cancellate fibres, vertical ribs often thick and woody. *Leaves* bifacial, channelled, 40–60 mm long, undulate, margins often lightly crisped, with hyaline, minutely ciliate border. *Flowers* stellate, pink-purple with a dark centre; *perianth tube* 13–30 mm long, dark-coloured; *tepals* broadly ovate, obtuse or acute, 15–25 mm long, spreading from the base, outer tepals 10–14 mm at widest point. *Filaments* 4–6,5 mm long, free for upper 1–2 mm, black or yellow; *anthers* 3–3,5 mm long, arcuate, reaching or exceeding the style branches. *Style branches* diverging at top of filaments with 3 distinct branches; *stigmas* undulate, broad, bordered by erect radial margins.



FIG. 3.

Distribution and morphology of *Galaxia barnardii* (approx. life size), with stamens and stigmas enlarged.

Chromosome number: $2n = 16$.

Flowering time: late August—September; flowers opening after 11h30, fading $\pm$ 16h00.

Distribution: clay soils in the Caledon district in the southwestern Cape (Fig. 3).

Galaxia barnardii is closely related to the more widespread *G. versicolor*, which occurs to the north and west in a generally similar habitat. Vegetatively they cannot be distinguished, but *G. barnardii* has somewhat larger, stellate flowers, with a dark centre and spreading tepals, while *G. versicolor* has campanulate flowers with cupped tepals and usually a yellow throat. Generally the stigmas are wider in *G. barnardii*, and borne near the apex of the anthers while in *G. versicolor* the style is much longer with the stigmas borne well above the anthers. *Galaxia barnardii*, with $2n = 16$ and *G. versicolor* with $2n = 16$ and 14, appear to be vicarious species which probably evolved fairly recently from a common ancestor.

The species has not been much collected, perhaps due to its blooming well only when the surrounding vegetation is cleared. Where it occurs it is often common, and makes a brilliant display for a few weeks in September. Collections from the Swartberg near Caledon, Marloth 70503 and Guthrie s.n., have been

assigned to *G. barnardii*, though in fact critical floral features cannot be seen in these specimens. Distribution and overall flower size suggest this determination.

CAPE—3319 (Worcester): dry clay slopes N. of Villiersdorp (-CD), *Goldblatt* 4006 (K, MO, PRE).

—3419 (Caledon): Swart Stomp Farm between Queen Anne and Eseljacht (-AA), *Barker* 10576 (NBG), *Goldblatt* 2499 (BOL, K, MO, NBG, PRE, S, WAG); S. slopes of Zwartberg near Caledon (-AB), *Guthrie* s.n. (BOL 16922), *Goldblatt* 584 (BOL), *Marloth* 70503 (PRE); Hemel en Aarde Valley E. of Shaws Pass (-AD), *Goldblatt* 4093 (MO, NBG), *Goldblatt* 4094A (MO); Kleinriviersberg, Steinige Bergplatze, *Ecklon and Zeyher* s.n. (*Zeyher* 4066, S).

2. ***Galaxia versicolor*** Salisb. ex Klatt, *Linnaea* 32: 783. 1863. Type: SOUTH AFRICA, Cape, mountain slopes near Cape Town, *Ecklon and Zeyher* 255 (B, not seen, perhaps destroyed). **Fig. 4.**



FIG. 4.

Distribution and morphology of *Galaxia versicolor* (approx. life size), with stamens and stigmas enlarged.

Galaxia versicolor Salisb., Trans. Hort. Soc. 1: 315. 1812. nomen nudum.

Galaxia ovata var. *versicolor* Salisb. ex Baker, Handbook Irid.: 97 et Flora Cap. 6: 33. 1896. Type: illustration in Jacquin, Ic. Pl. Rar. tab. 291, lower right figure.

Galaxia mucronularis Salisb., Trans. Hort. Soc. 1: 315. 1812, nomen nudum.

Galaxia ovata var. *mucronularis* Salisb. ex Baker, Handbook Irid.: 97. 1892 et Flora Cape. 6: 33. 1896. Type: illustration in Jacquin, Ic. Pl. Rar. tab. 291, lower left figure.

Galaxia ovata Thunb., var. *β corollis violaceis*, Thunberg, Gen. Nov. Pl.: 50. 1782.

Galaxia ovata var. *purpurea* Ker, Bot. Mag.: tab. 1516. 1812. Type: illustration in Bot. Mag.: tab. 1516.

Galaxia purpurea (Ker) Klatt, Erganz: 51. 1882.

Galaxia violacea Eckl., Top. Verz.: 17. 1826, nomen nudum.

Galaxia ovata var. *ecklonii* Baker, Handbook Irid.: 97. 1892. et Flora Cap. 6: 33. 1896. Type: SOUTH AFRICA, Cape, Devils Peak, Cape Town, *Ecklon* 308 (S, lectotype; K, MO, PRE, isotypes).

Plants usually solitary. *Corm* tunics dark brown, cancellate, with vertical ribs often thick and woody and becoming prominent. *Leaves* entirely bifacial, channelled or $\pm$ flat, lower often prostrate; obtuse to acute, often undulate and lightly crisped, 30–50 mm long and to 6 mm wide, but frequently very narrow; margins hyaline or red-flushed, border minutely ciliate. *Flowers* campanulate, shades of red, purple and pink, usually with a yellow tube and throat and deeply coloured at tepal midline above yellow throat; *perianth tube* (10–)15–22(–27) mm long; *tepals* 14–22 mm long, 7–10(–14) mm at widest point. *Filaments* 5–6 mm long, free apically for 1–1.5 mm and divergent; entirely yellow or dark in upper part; *anthers* arcuate, 1.5–2.5(–4) mm long. *Style* dilating near apex of anthers and extending well beyond them; *stigmas* entire, margin undulate, either free or contiguous at edges, radial margins erect, short.

Chromosome number: $2n = 16, 14$.

Flowering time: July–mid September; flowers open after 12h00 and fade at 16h30.

Distribution: slopes and flats in the southwestern Cape, extending from Houw Hoek and Viljoens Pass in the Caledon district to the Cape Peninsula and north to Gouda and the Tulbagh valley between Tulbagh and Waaihoek (Fig. 4).

Galaxia versicolor is variable in flower colour and marking. The distal part of the tepals are always evenly coloured, from red through purple to almost blue. The basal part of the tepals is commonly yellow with a dark band of colour separating yellow base and red-purple limb. Populations north of Stellenbosch, at Paarl, Tulbagh and Gouda, usually lack the yellow colour and the tepal base is then a very dark red to almost black. Anthers and filament column may also be dark

coloured in these forms. Most populations have broad spreading leaves reminiscent of *G. ovata* but plants from around Gouda have narrow erect grass-like leaves. Schlechter called his collections of this form *G. oxalidiflora*, but did not publish the name. Leaf structure apart, there is nothing to distinguish this form from nearby populations of *G. versicolor* and it does not appear to merit specific recognition in the light of available information.

Long confused with *Galaxia ovata*, *G. versicolor* has been known since Thunberg described it as a purple-flowered variety of *G. ovata*. Salisbury was the first to suggest specific recognition and he gave the names *G. versicolor* and *G. mucronularis* to Jacquin's figures of two forms of the species. As descriptions were not provided these names remained invalid until Klatt, in 1863, gave under the Salisbury name *G. versicolor*, a full description of a collection made by Ecklon and Zeyher. *Galaxia ovata* var. *purpurea* Ker, which was elevated to specific rank by Klatt in 1882 is exactly the same form of *G. versicolor* as Ecklon and Zeyher's type collection. Klatt's recognition of *G. versicolor* as a distinct species was strangely ignored and Baker in 1892 and 1896, and J. G. Lewis in 1950 continued to treat the species as only a variety of *G. ovata*. There is no doubt that *G. versicolor* is distinct, and it does not even seem to me closely related to *G. ovata*. Structurally the flowers differ with *G. ovata* having sessile anthers and fringed stigmas while *G. versicolor* has stalked anthers and entire, lobed stigmas. *Galaxia versicolor* is closely related to *G. barnardii* (see discussion under that species) and to *G. variabilis* though confusion with the latter is unlikely.

Galaxia versicolor is chromosomally heterogeneous (Goldblatt, 1980) with $2n = 16$ recorded in two populations from the Cape Peninsula and from plants in the Tulbagh Valley while $2n = 14$ occurs in plants from Stellenbosch, Paarl and Viljoens Pass. There are no consistent morphological differences between plants with the different chromosome numbers and the change in number is probably of recent origin with $2n = 16$ ancestral and $2n = 14$ derived by Robertsonian translocation (Goldblatt, 1980). Further counts should yield interesting data on evolution in this species and possibly also insights into the mechanism of chromosome change.

The species is fairly common between the northern Cape Peninsula and Tulbagh on clay soils, either on flats or lower mountain slopes. It generally occurs in transitional fynbos—coastal renosterbosveld, and flowers well only after the surrounding shrubs have been cleared or burnt.

Specimens said to have been collected at Hermanus (Salter 1185, 24 July 1931) must be viewed with misgiving. Either *G. versicolor* or *barnardii*, they may be mislabelled since neither species has ever been recorded near Hermanus. In addition neither species flowers as early as July and are in fact seldom found in bloom before September so far south. *Galaxia versicolor* does bloom earlier in the north, at Tulbagh and Paarl, but only from the second week of August.

CAPE—3218 (Clanwilliam): between Piketberg and Porterville (-DD), *Barnard s.n.* (BOL 31115).

—3318 (Cape Town): slopes of Devils Peak (-CD), *Ecklon 308* (K, MO, PRE, S), *Wolley Dod 1316* (BOL), *Goldblatt 2437* (K, MO, PRE, WAG); Signal Hill, *Page s.n.* (BOL 16068), *Marloth 464* (PRE), *Barker 433* (NBG), *Wilms 3676* (K); slopes of Lions Head, *Wolley Dod 1377* (K), *Pappe s.n.* (K, SAM), *Prior s.n.* (K, PRE 33487), *Barker 3872* (NBG), *Goldblatt 2434* (C, MO, WAG), 212 (BOL), *MacOwan s.n.* (Herb. Norm. 253, BOL, K, UPS); *Zeyher 5008* (SAM); Rondebosch, *Rehmann 1736* (BR); flats near Paarl (-DB), *Goldblatt 2301* (MO, S); Langverwacht, above Kuils River (-DC), *Oliver 4360* (STE); Agter Paarl road (-DD), *Loubser 2056* (NBG); clay slopes near Bottelary, *Acocks 2155* (S), *Simonsberg, Strey 498* (PRE).

—3319 (Worcester): between Breede R. and the Bokkeveld (-A), *Drège 1840* (K); flats S. of Tulbagh Station (-AC), *Barker s.n.* (NBG 88390), *Goldblatt 2309* (K, MO), 320 (BOL); Gouda commonage, *Goldblatt 2430B* (MO, PRE); hills near Gouda (Piketberg Road), *Schlechter 10706* (BOL, GRA, K, MO, PH, PRE, S), 10707 (BOL); Wabooms R., near Breede R. (-CA), *Esterhuysen 8956* (BOL).

—3418 (Simonstown): Bergvliet Farm, Cape Peninsula (-AB), *Purcell 163* (SAM); Sir Lowrys Pass (-BB), *Compton 14800* (NBG); Helderberg, Somerset West, *Parker 4228* (BOL, K, NBG, PH).

—3419 (Caledon): foot of Viljoens Pass (-AA), *Goldblatt 2490* (E, K, MO, PRE, WAG).

Without locality: Cape of Good Hope, *Thunberg s.n.* (K, S).

3. *Galaxia variabilis* Lewis, Jl S. Afr. Bot. 4: 6. 1938. Type: SOUTH AFRICA, Cape, between de Keur and Gydo, *Compton and party s.n.* (BOL, as NBG 2080/36, holotype, NBG, isotype). Fig. 5.

Plants solitary or in clumps. *Corm* tunics of brown, cancellate fibres, with vertical ribs often thickened and woody. *Leaves* entirely bifacial, canaliculate, acute, 30–60(–80) mm long, usually dark green and shiny, margins straight or undulate, hyaline, minutely cilio-serrate. *Flower* variously coloured pink, yellow or white, with a yellow throat; *perianth tube* 12–30 mm long, pale; tepals 20–35 mm long, ovate, obtuse, 10–13 mm at widest point, spreading distally, erect below. *Filaments* ± 6 mm long, free for less than 1 mm or entirely united; *anthers* 3–4 mm long, arcuate reaching just below stigmas. *Style branches* short, exceeding the anthers, *stigmas* entire, appressed to erect radial margins, later spreading horizontally and undulate.

Chromosome number: $2n = 14$.

Flowering time: September–October.

Distribution: Warm and Cold Bokkeveld, usually on clay flats, occasionally on deep sandy soil (Fig. 5).



FIG. 5.
Distribution and morphology of *Galaxia variabilis* (life size).

Galaxia variabilis grows mainly on clay soils, but occasionally on deep sand, in the Cold Bokkeveld and in the Warm Bokkeveld at the foot of the Skurweberg and Hex River Mountains. Populations typically have purple flowers with a yellow throat. Chromosome number is $2n = 14$, the karyotype consisting of 7 equally sized chromosome pairs.

In a few places populations are remarkably varied; one at Skoongesig has been documented by Hanekom (collections at PRE and K); others by myself below Gydo Pass and on the northern outskirts of Ceres. Plants in these variable populations exhibit a great range in flower size, and tepal colour varies from purple through orange to yellow and white, the latter colours usually found in the smaller-flowered plants. Chromosome number in these populations is $2n = 14$, and the plants appear fully fertile, more than 95 % pollen staining with cotton blue—lactophenol while capsules develop what appear to be fertile seed.

I believe that these variable populations represent hybrid swarms of a cross between *G. variabilis* and the yellow-flowered *G. citrina* which in the southern part of its range occurs in the same general areas as *G. variabilis*. *G. citrina* has

diploid numbers of $2n = 16$ and 14 , the latter only recorded from its southern limit, Gydo Pass. The great variability in these populations would be the result of crossing between hybrids. The general observation of yellow or white flowers being smaller in these populations would be consistent with segregation of linked characters of *G. citrina* recurring in later hybrid generations.

Galaxia variabilis and *G. citrina* are certainly closely related, with very similar flowers and almost identical vegetative structures. Artificial hybrids have been made in the greenhouse, and seeds from this cross have germinated though are yet to flower. These two species can be distinguished by different habitat preferences and by flower colour and tepal size as discussed under the following species, *G. citrina*.

Galaxia variabilis, with its low chromosome number, is probably the most specialized species of subgenus *Eurystigma*. It occupies the same type of habitat as the more lowland *G. versicolor* of which it may be a vicariad. The two, though similar, can readily be distinguished, *G. variabilis* having united filaments and *G. versicolor* filaments free and divergent in the upper third.

CAPE—3219 (Wuppertal): Skoongesig, Cold Bokkeveld, (-CC), *Hanekom* 1217, 1218, 1219, 1220, 1221 (K, PRE); Cold Bokkeveld near Elands Kloof, *Leighton* 1271 (BOL); between Twee Rivieren and Leeu R., *Goldblatt* 2574 (MO, WAG); de Keur (-CD), *Loubser* 2019 (NBG), *Barker* 3125 (NBG); Leeu R. drift, *Compton* 17359 (NBG); Leeurivier, *Lewis* 1410 (SAM).

—3319 (Worcester): between de Keur and Gydo (-AB), *Martin s.n.* (NBG 59320); 9 km N Gydo Pass, *Johnson* 503 (NBG), *Lewis* 2634 (SAM); Gydo, *Leipoldt* 3839 (BOL); top of Michells Pass (-AD), *Compton et al. s.n.* (NBG 59326); northern outskirts of Ceres, *Goldblatt* 4023 (MO, WAG); flats N of Prince Alfreds Hamlet, *Goldblatt* 2592 (K, MO, NBG, S); Welvaart, base of Sanddrift Peaks (-BC), *Oliver* 5072 (MO, STE); Lakenvlei, *Oliver s.n.* (NBG 59317).

4. *Galaxia citrina* Lewis, Jl S. Afr. Bot. **4**: 4. 1938. Type: SOUTH AFRICA, Cape, between de Keur and Gydo, *Martin s.n.* (BOL, holotype; NBG, isotype). **Fig. 6.**

Plants solitary. *Corm* tunics woody, medium to dark brown, usually with prominent vertical ribs. *Leaves* entirely bifacial, canaliculate, outer 30–70 mm long, acute, smooth and shiny, margin border hyaline, minutely ciliate. *Flower* yellow, occasionally marked with black near tepal base; *perianth tube* 13–28 mm long; *tepals* narrowly ovate, obtuse-apiculate, 18–30 mm long, 11 mm at widest point. *Filaments* entirely united, to 6 mm long; *anthers* 3.5–5 mm, reaching just below stigma lobes. *Style branches* joined laterally; stigma lobes entire, appressed to the short erect radial margins, later opening outwards.

Chromosome number: $2n = 16, 14, 34$.



FIG. 6.
Distribution and morphology of *Galaxia citrina* (life size).

Flowering time: (July-) August-September (-October); flowers opening after 11h00, fading 16h30.

Distribution: moist shallow sandy soil overlying sandstone rock, mainly in the Cold Bokkeveld but extending from Ceres and Gydo Pass to Nieuwoudtville (Fig. 6).

Galaxia citrina is predominantly a montane species with its main range in the Cedarberg and northern Cold Bokkeveld above 700 m and up to 2 000 m. It extends north with isolated populations near Nieuwoudtville, and south occurring around Gydo Pass. Typically it grows in shallow, moist sandy soil overlying sandstone rocks, often in wet seeps. It is closely related to *G. variabilis* and when dry, larger-flowered forms can be distinguished only with difficulty. Vegetatively the two species are almost identical, but *G. citrina* always has yellow flowers, and relatively narrower tepals so that when fully open, gaps can be seen between them, a distinction emphasized by Lewis (1938). In contrast, *G. variabilis* usually has purple flowers with a yellow throat, and the tepals are usually broad and overlapping one another in the open flower. Over the main part of its range *G. citrina* has fairly small flowers, tepals 18–22 mm long. Plants from Nieuwoudtville, and from the type area near Gydo Pass have larger flowers, with tepals 23–28 mm long, a size more typical of *G. variabilis*, but these plants have tepals no more than 11 mm wide while *G. variabilis* usually has wider tepals.

Galaxia citrina has a diploid number of $2n = 16$ over part of its range, but is aneuploid with $2n = 14$ in plants from near the type locality, and polyploid with $2n = 34$ in a population from Rosendal in the eastern Cold Bokkeveld. As discussed under *G. variabilis*, the previous species, putative hybrids occur in several sites between *G. citrina* and *G. variabilis*.

CAPE—3119 (Calvinia): top of Van Rhyns Pass, W. of Nieuwoudtville (-AC), Marloth 12933 (PRE), Plowes 3230 (PRE), Lewis 5895 (NBG), Goldblatt 2470 (E, MO, PRE, WAG); hills W. of Nieuwoudtville, Goldblatt 3692 (MO), Barker 6471 (NBG, PRE).

—3219 (Wuppertal): Cedarberg, Sneeuweberg (-AC), Esterhuysen 13037 (BOL); Cedarberg Tafelberg, Esterhuysen 8104 (BOL); Bushmans Cave, Barnes s.n. (BOL 19444); Sneeuwekop, Cedarberg, Bodkin s.n. (BOL); Elandskloof (-CA), Barker 3124, 3799 (NBG), Leighton 1271 (BOL, K); 33 km E. Citrusdal in Cold Bokkeveld, Goldblatt 4024 (MO); Waboomsrivier (-CC), Hanekom 634 (PRE), 677 (K), Lewis 1411 (SAM); 40 km E. Citrusdal (-CD), Goldblatt 318 (BOL); Rosendal, Cold Bokkeveld, Goldblatt 4672 (MO).

—3319 (Worcester): top of Gydo Pass (-AB), Johnson 499 (NBG), Goldblatt 2588A (MO), Lewis 2633 (SAM); Gydo, Leipoldt 4078 (BOL); between Gydo and de Keur, Martin s.n. (BOL, NBG 59322, PRE).

2. SUBGENUS GALAXIA

Subgenus *Galaxia*

Type species: *Galaxia ovata* Thunb.

Leaves bifacial or unifacial distally, prostrate or erect. Flowers large to small, usually yellow, occasionally white. Stigmas irregularly fringed, radial margins often erect but minute.

Chromosome numbers: $2n = 18, 27, 36$.

Distribution: southern Cape to Namaqualand, centered in the western coastal belt from the Cape Peninsula to the Cedarberg.

5. *Galaxia grandiflora* Andr., Bot. Rep. tab. 164. 1801. Type: illustration in Andr. Bot. Rep., grown in England and probably collected by Niven in the Kamiesberg.

Plants solitary. *Corms* brown, with cancellate to fibrous tunics. *Leaves* entirely bifacial, oblong—obtusate to 30 mm long, ascending, shallowly channelled, margins hyaline, ciliate. *Flowers* clear yellow; *perianth tube* 15–25 mm long; *tepals* 22–30 mm, ovate, 11–15 mm at widest point, obtuse—obtuse-apiculate. *Filaments* 6 mm long, entirely united; *anthers* 4–5 mm. *Style* extending about 4 mm above anthers, branches short, stigmas irregularly fringed with short erect radial margins.

Chromosome number: $2n = 18$.

Flowering time: early to mid September; flowers opening 11h00–12h00, fading 16h00.

Distribution: local in sandy soils in the Kamiesberg (Fig. 7).

Though collected at several sites in the upper Kamiesberg *Galaxia grandiflora* is nowhere common. The plants from which the type illustration was made were part of George Hibbert's collection and they were almost certainly gathered by James Niven, the botanist employed by Hibbert to collect plants at the Cape for his private collection. Niven is known to have visited the Kamiesberg (Rourke, pers. comm.) most likely in 1800 when he collected *Leucospermum alpinum* and probably the first plants of *Moraea longiflora* (Goldblatt, 1976b).

Galaxia grandiflora was overlooked in botanical literature from the later nineteenth century until now, the type figure probably mistaken for *G. ovata*, which though similar has prostrate leaves. The flower is identical in both species, but those of *G. grandiflora* are considerably larger. The leaves also differ, for those of *G. ovata* are small, generally ovate, and the lower ones prostrate, while those of *G. grandiflora* are not only larger, but are channelled, and somewhat falcate as is clearly shown in the type figure. Despite its size, *G. grandiflora* is a diploid species, while most populations of *G. ovata* are tetraploid.

The rediscovery of living plants of *Galaxia grandiflora* was made by E. G. Oliver, who collected and grew a few specimens of this unusual *Galaxia* he found in the Kamiesberg. When first shown the cultivated plants I believed them to be a new species, but subsequent study has shown that they are identical to the long ignored *G. grandiflora*.

CAPE—3018 (Kamiesberg): E. slopes of Rooiberg, near Welcome, 1 100 m (-AC), Goldblatt 4049 (K, MO, NBG, PRE, S); Leliefontein, heights at foot of Ezelskop, Drège 1839 (S); between Leliefontein and Ezelskop, Drège s.n. (K); sandy places in Khomsoap Ravine; Pearson 6547 (BOL, K, PRE).

6. *Galaxia ciliata* Persoon, Synopsis 1: 41. 1805. Type: illustration in Andrews' Bot. Rep. tab. 94. 1800.

Plants solitary or in small clumps. *Corm* tunics brown, cancellate becoming finely fibrous, usually accumulating to form a thick mass round the corm. *Leaves* entirely bifacial, ascending and slightly recurved, channelled, often lightly undulate, oblong, obtuse; margins thickened and hyaline, densely ciliate-villous. *Flowers* yellow, campanulate; perianth tube 4.5–10 mm; tepals 14–16 mm long, ovate, obtuse, 8–9 mm at widest point. *Filaments* entirely united, 3.5–4 mm long; *anthers* divergent, 2.5–3.5 mm long, almost reaching to stigmas. *Stigma* irregularly fringed.

Chromosome number: $2n = 18$.

Flowering time: June–July (-early August).

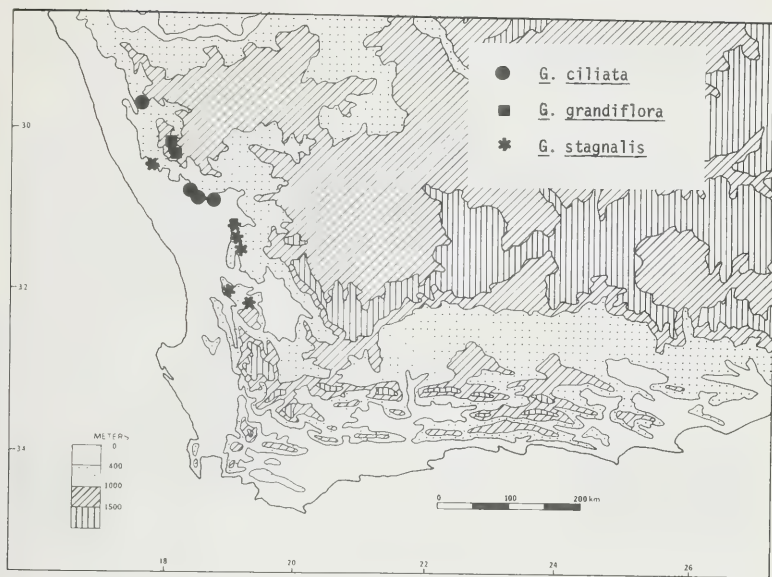


FIG. 7.
Distribution of *Galaxia grandiflora*, *G. ciliata*, and *G. stagnalis*.

Distribution: very local on clay slopes in Namaqualand, and recorded from the Nuwerus area in the south and from Spektakel Pass west of Springbok. (Fig. 7).

Galaxia ciliata is a rare species known only from a few sites in Namaqualand where it has been recorded only on clay soils which are very localised in this region of predominantly granitic rocks. It is rather inconspicuous, with small pale yellow flowers and appears to bloom irregularly from season to season, in dry years only producing very small leaves.

The species was first referred to *Galaxia ovata* when it appeared in Andrews' *Botanical Repository* and was only later recognised as distinct by Persoon in 1805. *Galaxia ciliata* is easily distinguished by its short, broad, channelled leaves with conspicuous long marginal hairs or cilia. The species is diploid, $2n = 18$, and seems related to the very much larger-flowered *G. grandiflora* from the Kamiesberg, and to the ovate, prostrate leafed *G. ovata*, widespread in the southwestern Cape.

CAPE—2917 (Springbok): clay slopes on E. approach to Spektakel Pass (-CC), Goldblatt 2357 (K, MO, NBG, PRE, WAG).

—3118 (Van Rhynsdorp): Bitterfontein (-AA), Salter 929 (K); Kareeberg (-AB), Schlechter 8218 (B, BOL, K, MO, PH, PRE, S); clay flats near Nuwerus, Goldblatt 3640 (K, MO, PRE, S).

7. *Galaxia luteo-alba* Goldbl., sp. nov.

Tunicae cormi atrobrunneae, fibrosae. Folia bifacialia ovato-oblonga, inferiora prostrata, 20–30(–40) mm longa, marginibus perciliatis. Flores lutei in centro, albescens ad margines tepalarum; tubus perianthii 7–16 mm longus; tepala ovata, obtusa 15–21 mm longa, 7–10 mm lata. Filamenta 5–7,5 mm longa, connata prope basin, divergentia; anthera 2–3 mm longa. Stylus gracilis, erectus, deflexens, antheras excedens; stigmata fimbriata.

Type: SOUTH AFRICA, Cape, Pakhuis Pass, Cedarberg, Goldblatt 2205 (MO, holotype; K, NBG, PRE, S, isotypes). **Fig. 8.**

Plants usually solitary or in small clumps. *Corm* tunics dark brown, matted and fibrous. *Leaves* bifacial, ovate-oblong, lower prostrate 20–30(–40) mm long, usually obtuse, up to 5 mm wide; margins with hyaline border prominently ciliate; cilia 2–3 times the width of border. *Flowers* deep yellow in the throat, fading to cream at tips of tepals; *perianth tube* 7–16 mm long; *tepals* ovate, obtuse 15–21 mm long, 7–10 mm at widest point. *Filaments* 5–7,5 mm long, free in upper two thirds, spreading; anthers 2–3 mm long. *Style* slender, extending 10 mm from throat of perianth tube, initially erect, and much exceeding the anthers, becoming declinate; branches short, stigmas fringed, radial margins erect, short.

Chromosome number: $2n = 18, 27$.

Flowering time: July–August; flowers opening about 11h00, closing 16h00–16h30.

Distribution: moist shallow sandy soil on rock shelves in the Cedarberg, and north near Nieuwoudtville (Fig. 8).

Galaxia luteo-alba is distinctive in being the only member of the genus with filaments free almost to the base. When the buds first open the stamens are erect, and held close together round the style, but later when the flowers are fully open the stamens separate and spread outwards while the style bends to one side. The flower colour is also distinctive, deep yellow in the throat, becoming lighter gradually towards the edge of the tepals so that the tips are cream-white. This colouration is unique for subgenus *Galaxia*, but is also found in some hybrids of *G. citrina* $\times$ *G. variabilis* (subgenus *Eurystigma*).

It is easy to recognise live flowering material of *Galaxia luteo-alba* from the characteristic colour, and the free stamens. Problems do arise with poorly dried specimens but leaf shape should serve to distinguish *Galaxia luteo-alba* from all species except *G. ovata*, and in this case the ciliation of the leaf margins is usually

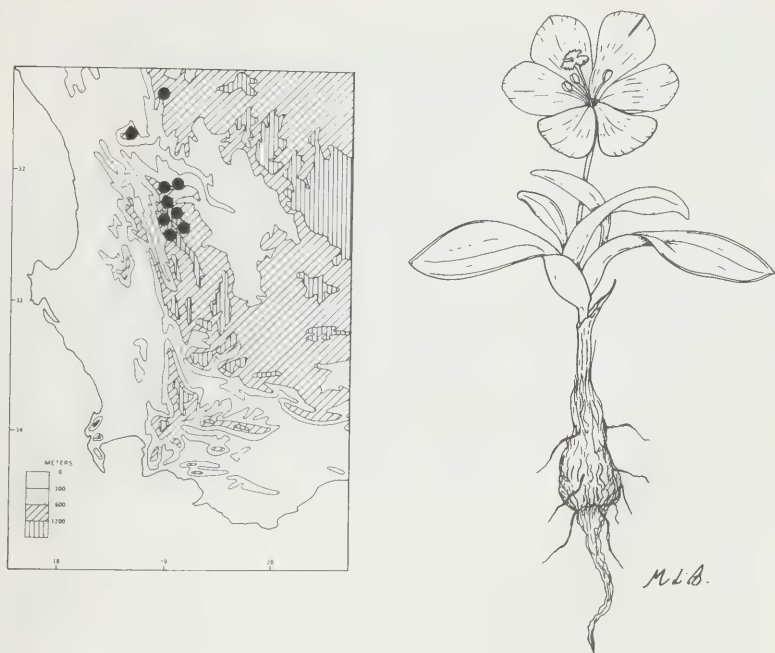


FIG. 8.
Distribution and morphology of *Galaxia luteo-alba* (approx. life size).

reliable. Cilia are much longer in *G. luteo-alba*, up to three times the width of the hyaline leaf border, and visible to the naked eye. In *G. ovata* the cilia are shorter, seldom even twice the width of the leaf border, and in many forms of this species, though not the northern populations, the cilia are scattered all over the leaf border instead of in the usual single row.

I have found *Galaxia luteo-alba* to be very common in the Cedarberg, where it extends from the Stadsaal Rocks near Matjiesrivier to Pakhuis Pass and Brandewyn River. There is also a collection from south of Nieuwoudtville, (*Leipoldt* 3838) which needs confirmation, for this area is well-collected and the species has not been recorded by others. *Galaxia luteo-alba* always occurs in wet habitats, in shallow sandy soil overlying sandstone rock. Altitude seems unimportant with plants found from 500–1 400 m.

There are three other species of *Galaxia* in the Cedarberg, two of which may grow near *G. luteo-alba*. The tetraploid *G. ovata* occurs in close proximity to *G. luteo-alba* in many places but tends to occupy drier sites with deeper, better

drained soil. *Galaxia stagnalis* is virtually sympatric with *G. luteo-alba* north of Pakhuis Pass. *Galaxia stagnalis* usually occurs half-submerged and in water-logged soil, and blooms earlier in this area than *G. luteo-alba*, which only flowers when the soil begins to dry. *Galaxia citrina* is found mainly at higher elevations and I have not seen it growing near *G. luteo-alba*.

CAPE—3118 (Van Rhynsdorp): Giftberg (-D), *Phillips* 7564 (SAM); Nardouwsberg (-DC), *Stokoe* s.n. (SAM 60187).

—3119 (Calvinia): between Nieuwoudtville and Oorlogskloof (-CC), *Leipoldt* 3838 (BOL).

—3219 (Wuppertal): Top of Pakhuis Pass (-AA), *L. Bolus* s.n. (BOL 31112), *Goldblatt* 568 (BOL); Pakhuis Pass near Leipoldt's Grave, *Goldblatt* 2205 (K, MO, NBG, PRE, S), *Nordenstam & Lundgren* 1330 (MO, S); Heuningvlei, *Esterhuysen* 8066 (BOL), *Stokoe* s.n. (SAM 55677); between Pakhuis and Brandewyn River, *Goldblatt* 3881 (MO, NBG); Cedarberg, Middelberg (-AC), *Kerfoot* 5968 (NBG); near Middelberg hut, *Barnes* s.n. (BOL 19445); Wolfberg, *Esterhuysen* 20569A (BOL); southern Cedarberg at Krom River turnoff (-CB), *Goldblatt* 3872 (K, MO, PRE, WAG); Stadsaal Rocks, *Goldblatt* 3877 (K, MO, PRE, WAG).

8. *Galaxia ovata* Thunb., Gen. Pl. Nov.: 50. 1782, excl. var β corollis violaceis. Type: SOUTH AFRICA, Cape, around Cape Town, *Thunberg* s.n. (Herb. Thunb. 15450, UPS, lectotype, C, S, isotypes.) **Fig. 9.**

Ixia galaxia L.f., Suppl.: 93. 1781. Type: SOUTH AFRICA, Cape, Cape Peninsula, *Sparrman* s.n. (S. lectotype).

Plants solitary or often forming small cushion-like tufts. *Corm* tunics brown, reticulate often with prominent vertical ridges. *Leaves* bifacial, ovate, obtuse, apiculate, outermost leaves prostrate, 20–30 mm long; margin border thickened, hyaline, minutely ciliate; cilia either uniseriate or scattered over entire border. *Flowers* yellow, campanulate; *perianth tube* 5–20 mm long; *tepals* 16–20 mm long, ovate, 8 mm wide, obtuse. *Filaments* entirely united, 4–5 mm long, *anthers* 2–3 mm long, erect. *Style* erect, extending well above anthers; *stigmas* fringed.

Chromosome number: $2n = 18, 36$.

Flowering time: July–August–mid September in the southern Cape; flowers opening 10h30 closing 16h00.

Distribution: southwestern Cape, from Elim in the east to the Cedarberg in the north; most frequently in sandy soil (Fig. 9).

Galaxia ovata is common throughout its range from Elim in the southern Cape to the Cedarberg in the north. Its characteristic feature is its small prostrate leaves. Plants in the southeast of its range are diploid, $2n = 18$, usually solitary, and occur on heavy clay soils. Elsewhere *G. ovata* is tetraploid, $2n = 36$, forms large

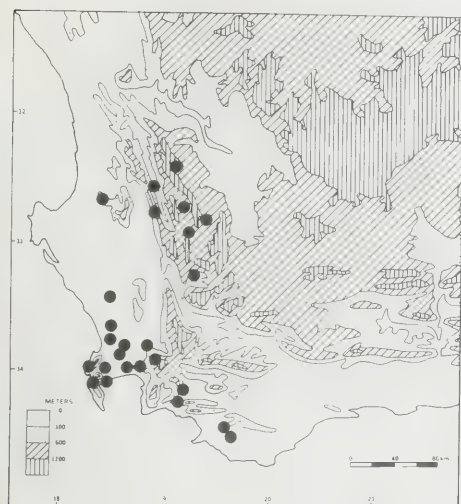


FIG. 9.
Distribution and morphology of *Galaxia ovata* (approx. life size).

clumps and grows mainly in sandy soils. In the south it grows at low to mid altitudes, while to the north it occurs above 1 000 m. Many populations have a very distinctive border to the leaf margin, which is covered by many tiny cilia. In the southeast and in the north however, marginal cilia are restricted to a single row.

This species occurs together with or close to *Galaxia fugacissima* in many localities, amongst *G. alata* in at least one place, and close to *G. luteo-alba* in the Cedarberg. Hybrids are not known, but I have occasionally seen plants with leaves intermediate between the narrow ones of *G. fugacissima* and the broad ones of *G. ovata*. To date I have not been able to grow any of these plants to examine their cytology which would confirm hybridity since the presumed parents are diploid and tetraploid.

Galaxia ovata is selected as the type species of *Galaxia* as it was the first of the two species assigned to the genus by Thunberg when he described the genus. Thunberg's concept of this species included *G. ovata* as here circumscribed, and *G. versicolor*. He distinguished these as var. α *corollis totis flavis* (the more

common) and var β *corollis violaceis*. In selecting the yellow-flowered plant as the type for *G. ovata*, *G. versicolor* is now excluded entirely from *G. ovata*.

CAPE—3218 (Clanwilliam): slopes above Aurora, Piketberg distr. (-BB), *Lewis* 5945 (NBG); north side of Grays Pass (-DB), *Leipoldt* s.n. (K).

—3219 (Wuppertal): Cedarberg, Driehoek road (-AC), *Goldblatt* 3878 (K, MO, NBG, PRE, S); between de Keur and Elandskloof Mission (-CD), *Martin* s.n. (NBG 59296), *Compton et al.* s.n. (NBG 59255); between Twee Rivieren and Leeu R., *Goldblatt* 2575 (MO); Bo-Bokfontein, *Nordenstam & Lundgren* 1271 (MO, S).

—3318 (Cape Town): Clifton, Cape Town (-CD), *Barker* 1877 (NBG); near Rondebosch, *H. Bolus* 4577 (BOL); Koeberg, 40 km S. Malmesbury (-DA), *Goldblatt* 2174 (MO, WAG); 20 km S. Malmesbury, *Goldblatt* 2177 (MO, NBG); Tygerberg (-DC), *Burchell* 971 (K); Peaslake, Durbanville, *Taylor* 4951 (NBG, PRE).

—3319 (Worcester): flats near Prince Alfreds Hamlet (-AD), *Oliver* 4972 (MO, STE), *Goldblatt* 2230 (MO, WAG); lower slopes Gydo Pass, *Acocks* 282 (S); between Salt R. and Kalabaskraal (-DA), *Hutchinson* 160 (K, PRE); Jonkershoek (-DD), *Garside* 612 (K); Stellenbosch flats, *Garside* 1075 (K); Duthie Reserve, Stellenbosch, *Bos* 243 (PRE).

—3418 (Simonstown): Llandudno (-AB), *Compton* 8889 (NBG), *Goldblatt* s.n. (BOL); lower slopes of Constantiaberg, *Schlechter* 988 (PRE); Faure (-BB), *Strey* 554 (PRE); Somerset West, *Parker* 3813 (K); between Somerset West and Strand, *Bos* 293 (PRE).

—3419 (Caledon); Nuwedam, between Elim and Stanford (-DA), *Goldblatt* 2609 (MO).

9. *Galaxia stagnalis* Goldbl., sp. nov.

Planta solitaria. Tunici cormi fibrosi, saepe unguibus prominentibus. Folia bifacialia, linearia vel lanceolata, acuta, raro obtusa, marginis raro pauci-ciliatis. Flores lutei; tubus perianthii 5–10 mm longus; tepala 10–15 mm longa, ovata, 5–8 mm lata, obtusa. Filamenta connata ad apice vel libera in parte superiore, 4,5–5 mm longa; anthera 1,5–2,0 mm. Stylus antheras non excedens; stigma fimbriata, recurva, antheras contigua.

Type: SOUTH AFRICA, Cape, pools at the top of Van Rhyns Pass, *Goldblatt* 3888 (MO, holotype; K, NBG, PRE, S, isotypes).

Plants solitary. *Corm* tunics of fine matted fibres or with prominent vertical claws. *Leaves* bifacial, straight, erect or prostrate, linear or lanceolate, acute, occasionally obtuse, margin border usually smooth, rarely with minute scattered cilia. *Flowers* yellow, campanulate; *perianth tube* 5–10 mm long; *tepals* 10–15

mm long, 5–8 mm wide, ovate, obtuse. *Filaments* 4.5–5.0 mm, entirely united, or free in upper third; *anthers* 1.5–2.0 mm, diverging. *Style* dividing at level of anthers, stigmas fringed, recurved and touching anthers.

Chromosome number: $2n = 36$.

Flowering time: June - early August; flowers open about 11h30, fade about 16h00.

Distribution: seasonal pools, wet seeps, streams, with roots and corms submerged, in the northern Cedarberg, Nardouw Mountains and Nieuwoudtville escarpment, and locally in Namaqualand (Fig. 7).

Galaxia stagnalis is a rather variable complex comprising small-flowered plants of the northern Cedarberg, Nardouw mountains and Nieuwoudtville escarpment. A collection from Garies in Namaqualand, *Lewis s.n.*, also appears to belong in this species, though this is rather far from the main range of *G. stagnalis*. All populations that I have seen grow partly submerged in water, either in temporary pools or in the course of small seasonal streams, and plants flower very early in the season, usually in June or July, blooming as the water level drops below the buds. Flowers are very small, with a short perianth tube. In most populations the anthers are shortly stalked, and the rather broad, fringed stigmas recurve to come in contact with the pollen. Plants grown from four separate populations have all proved polyploid, $2n = 36$, and are self-compatible and autogamous in cultivation, an unusual feature for Iridaceae, and *Galaxia*, but also known for *G. albiflora*, and some very small-flowered forms of *G. fugacissima*.

Galaxia stagnalis appears related to *G. ovata*, many populations of which are also tetraploid, but it has narrower leaves which are seldom truly ovate and prostrate. It is probably no more closely related to *G. ovata* than to other broad-leafed species of subgenus *Galaxia*, such as *G. ciliata*, and *G. luteo-alba*. Good taxonomic characters are lacking in most species of the subgenus so that little more can be said about its relationships. *Galaxia stagnalis* can be recognized from its habitat, early blooming, small flowers, often stalked anthers and short style. Leaf border is often distinctive, usually lacking entirely the marginal cilia found in all related species.

CAPE—3017 (Hondeklipbaai): Garies (-DB), *Lewis s.n.* (BOL).

—3118 (Van Rhynsdorp): Nardouw Mts above Doorn R., (-DC), *Goldblatt 2191* (MO, NBG).

—3119 (Calvinia): top of Van Rhyns Pass (-AC), *Goldblatt 2468* (BOL, MO, WAG), *Goldblatt 3888* (K, MO, NBG, PRE, S), *Hall 2479* (NBG); Lokenberg, *Acocks 18229* (PRE); 7 km N.W. of Nieuwoudtville, rock seep, *Goldblatt 3958* (MO).

—3219 (Wuppertal): Brandewyn River, seasonal stream bed (-AA), *Goldblatt 2203* (MO, WAG); between Pakhuis and Brandwyn R., *Goldblatt 3883* (M¹).



FIG. 10.

Distribution and morphology of *Galaxia fugacissima* (life size) with stamens and stigmas enlarged.

10. *Galaxia fugacissima* (L.f.) Druce, Rep. Bot. Exch. Club. Br. Is. 1916: 624, 1917. Fig. 10.

Ixia fugacissima L.f., Suppl.: 94. 1781. Type: South Africa, Cape, Cape Town, Thunberg s.n. (Herb. Thunb. 15449, UPS, lectotype)

Galaxia graminea Thunb., Nov. Gen.: 50. 1782. Type: South Africa, Cape, Cape Town, Thunberg s.n. (Herb. Thunb. 15449, UPS, holotype); nom illeg., superfl.

Galaxia graminifolia Harv., orth. var pro *G. graminea* Thunb.

Plants solitary or forming thick clumps. *Corm* tunics brown, fibrous, occasionally with conspicuous vertical ribs. *Leaves* 30–80 mm long, linear, bifacial and channelled, either with a short acute unifacial apex or unifacial in upper half, $\pm$ erect, spreading or falcate; margins of bifacial portion with a hyaline border, smooth or minutely ciliate. *Flowers* pale yellow, sweet scented; *perianth tube* 10–24 mm long; *tepals* (11–)15–19 mm long, ovate, obtuse, 4–9 mm at widest point. *Filaments* usually entirely united, (3–)5–6 mm long occasionally free in upper third; *anthers* 1.5–4 mm, diverging. *Style* usually reaching beyond anthers, occasionally not exceeding anthers; *style branches* short, stigmas fringed.

Chromosome number: $2n = 18, 36$.

Flowering time: July to mid September; flowers open 10h30–11h00, fading 16h00.

Distribution: widespread in the southern and southwestern Cape and extending locally in Namaqualand to Springbok; usually on seasonally waterlogged sandy soils, smaller forms occur on clay in the southern Cape (Fig. 10).

Galaxia fugacissima is distinctive in *Galaxia*, being the only species with linear, grass-like leaves. In most forms the leaves are unifacial distally and quite straight. In the northern forms from Namaqualand which I have assigned to this species, the leaves are strongly falcate, but still very narrow while in the south, from Caledon eastwards, and especially in drier sites, the leaves tend to be somewhat broader and spreading, and sometimes grooved and bifacial almost to the apex.

In flower structure there is nothing to distinguish *Galaxia fugacissima* from most other species of subgenus *Galaxia* but all forms of the species that I have seen live have a strong sweet scent, a character not noted in other species. Plants east of the Hottentots Holland Mountains usually have smaller flowers, and often grow on clay, rather than the typical wet sand habitat. Some of these small-flowered forms from near Caledon, at Drayton and Middleton, exhibit variation in style length, with many plants having a short style so that the stigmas are in contact with the anthers. These plants are autogamous, while other populations studied are strongly self-incompatible. Though the small-flowered and self-compatible, autogamous populations would seem to merit taxonomic recognition at least at subspecific level, it is in practice often quite impossible to recognize them from herbarium material and I have therefore avoided this issue.

West and north of the Hottentots Holland *Galaxia fugacissima* grows in damp sites, usually on sandy flats that are very wet in the winter. It is sympatric with *G. albiflora* on Rondebosch common, where hybrids occur. These hybrids are discussed in detail under *G. albiflora*. *Galaxia fugacissima* also grows with *G. versicolor* at some sites, and in other places with *G. ovata* and in the latter situations I have seen some broader-leaved plants which may be hybrids.

Galaxia fugacissima is believed to have been collected first by Thunberg, who found it to be plentiful on the Cape Peninsula. No doubt it was this species flowering in profusion like the massed stars of a galaxy which suggested to Thunberg the generic name *Galaxia*. Although the younger Linnaeus described this species, assigning it to *Ixia*, Thunberg's later specific epithet "graminea" was widely used until well into the twentieth century when Druce drew attention to the existence of the earlier name for the species.

CAPE—2917 (Springbok): 30 km S. Springbok (-DD), Compton 20729 (NBG).

- 3018 (Kamiesberg): Leliefontein (-AC), *Goldblatt* 2408 (E, MO, PRE, S); top of Studers Pass, *Goldblatt* 3972 (K, MO, NBG).
- 3219 (Wuppertal): Citrusdal Vlei (-CA), *Compton* 17431 (NBG, PRE), *Goldblatt* 2232 (E, MO, PRE, S); 10 m N. of Citrusdal, *Lewis* 1034 (SAM); Leeu R., Cold Bokkeveld (-CC), *Barker* 3803 (NBG, PRE).
- 3318 (Cape Town): near Cape Town (-CD), *Thunberg s.n.* (UPS), *MacOwan* in Herb Norm. Aust. Afr. 1539 (BR, K, SAM, UPS), *H. Bolus s.n.* (BOL 4806, K); Rondebosch Common, *Isaac s.n.* (BOL), *Goldblatt* 321 (BOL), *Lewis* 671 (SAM); Gardens, Cape Town, *Burchell* 8396 (K); Camps Bay, *Ecklon* 330 (BOL, K, MO); Wellington (-DB), *Kies* 102 (PRE); Durbanville (-DC), *Taylor* 5004 (K, PRE); Stellenbosch flats (-DD), *Garside* 1020 (K), *Worsdell s.n.* (K).
- 3319 (Worcester): Agterwitzenberg Vlake (-AB), *Goldblatt* 2589 (MO, WAG); between Bains Kloof and Wolseley (-CA), *Goldblatt* 2430 (BOL); Bothas Halt, *Compton* 18275 (NBG, PRE); near Worcester (-CB), *Steyn* 199 (BOL, PRE); Ceres, *Rogers* 28735 (SAM).
- 3320 (Montagu): near Baths at Montagu (-CC), *Page s.n.* (BOL 15625).
- 3321 (Ladismith): Muiskraal vlei (-CC), *Galpin* 4654 (GRA, K, PRE).
- 3323 (Willowmore): headwaters of Wagenbooms R. (-D), *Fourcade* 2673 (K).
- 3418 (Simonstown): Wynberg Hill (-AB), *Schlechter* 1577 (GRA).
- 3419 (Caledon): foot of Viljoens Pass (-AA), *Goldblatt* 2490A (MO); Middleton, E. Caledon (-AB), *Goldblatt* 2631 (MO, NBG, PRE); Hermanus (AC), *Salter* 1192 (K); Kleinrivier Mts (-AD), *Zeyher* 4065 (K, SAM); Drayton siding, E. Caledon (-BA), *Goldblatt* 2515 (K, MO, S); Elim (-DA), *Frowein* 1087 (PRE).
- 3420 (Bredasdorp): near Swellendam (-AB), *F. Bolus s.n.* (BOL 23384); The Poort, Bredasdorp (-CA), *Compton* 14802 (NBG); near Bredasdorp, *Morris* 274 (BOL, NBG).
- 3421 (Riversdale): hills near Riversdale (-AB), *Muir* 2574 (BOL, PRE).
- 3424 (Humansdorp): Humansdorp (-BB), *Fourcade* 2316 (BOL).

11. *Galaxia alata* Goldbl., sp. nov.

Tunicae cormi pallidae, medullosae, prominentibus alis. Folia bifacialia infra, marginibus ciliatis, teretia supra, $\pm$ succulenta, falcata vel $\pm$ erecta, 15–30(–60) mm longa. Flores albi vel flavi; tubus perianthii 5–20 mm longus; tepala 1,3–1,9 cm ovata, obtusa. Filamenta 4–5 mm longa, connata; antherae 2,0–2,5 mm longae. Stylus antheras excedens, rami breves, stigmata fimbriata.

Type: SOUTH AFRICA, Cape, roadside 20 km S. of Malmesbury at Klein Dassenberg intersection, *Goldblatt* 2176 (MO, holotype; K, NBG, PRE, S, isotypes). **Fig. 11.**

Plants usually solitary, small, 20–40 mm tall. *Corm* tunics pale, entire, composed of pith-like material, with several conspicuous vertical wings. *Leaves*



FIG. 11.

Distribution and morphology of *Galaxia alata* (approx. life size) with stamens and stigmas enlarged.

bifacial below, distally terete, somewhat succulent, outspread to falcate, 15–30(–60) mm long, bifacial portion with hyaline, minutely ciliate margin. *Flowers* white or yellow; *perianth tube* 5–20 mm long; *tepals* 13–19 mm long, ovate, obtuse, 6,5–8,0 mm wide. *Filaments* entirely united, 4–5 mm long; *anthers* sessile, 2,0–2,5 mm long diverging from base. *Style* extending $\pm$ 4 mm above *anthers*, branches short; *stigmas* irregularly fringed.

Chromosome number: $2n = 18, 27$.

Flowering time: July–August; flowers open ca. 12h00 and fade ca. 15h30.

Distribution: moist, usually sandy situations, on the flats between Cape Town, Malmesbury and the Hottentots Holland Mountains (Fig. 11).

Galaxia alata is apparently a very rare species of the flats between the Hottentots Holland Mountains and the west coast between Cape Town and Darling. Except when in flower it is inconspicuous, with its tiny leaves barely noticeable in the surrounding vegetation. The flower is typical of subgenus *Galaxia* in size and structure, but vegetatively this species is most distinctive. Its corms are remarkable, being unique in the genus with tunics consisting of an

entire layer of bony material which has several prominent vertical wings. The leaves are also unusual in being terete in the upper half and slightly succulent. Both the leaves and corms of this species are unmistakable.

I have seen only two live populations, one south of Malmesbury, where yellow and white flowered plants occur, and one near Mamre Road, where all individuals have yellow flowers. South of Malmesbury most plants are diploid, $2n = 18$, with an occasional triploid, $2n = 27$, perhaps cryptic hybrids with *G. ovata* ($2n = 36$) which grows at the same site. All plants examined from the Mamre Road locality are triploid and do not reproduce by seed, but by cormlets produced at the base of the sterile ovaries.

CAPE—3318 (Cape Town): Ysterfontein (-AC), *Barker* 3845 (NBG); near Mamre Road Station (-BC), *Goldblatt* 3825 (K, MO, NBG); Claremont (-CD), *H. Bolus* 3759 (BOL, K); Salt River, sandy flats, *Marloth* 161 (PRE); racecourse at Kenilworth, *H. Bolus* s.n. (BOL 1892); 20 km S. Malmesbury (-DA), *Goldblatt* 617 (BOL), 2176 (K, MO, NBG, K, S), 2231 (C, E, MO, WAG); near Stellenbosch (-DD), *Guthrie* s.n. (BOL 18572).

—3418 (Simonstown): Kalk Bay Mt, above the Fishery (-AB), *F. Bolus* s.n. (BOL 13713); Bergvliet farm, *Purchell* s.n. (SAM); Isoetes Vlei (-BA), *Rowe* 25 (NBG); Somerset West (-BB), *Parker* 4214 (BOL, K, NBG).

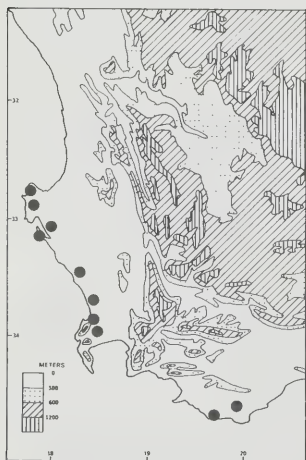


FIG. 12.
Distribution and morphology of *Galaxia albiflora* (life size) with stamens and stigmas enlarged.

12. *Galaxia albiflora* Lewis, Jl S. Afr. Bot. 7: 44. 1941. Type: South Africa, Cape, Rondebosch Common, *Lewis s.n.* (SAM 54289). **Fig. 12.**

Plants solitary. *Corm* tunics dark brown with vertical ribs usually prominent, and woody. *Leaves* 30–60 mm long, linear, bifacial, channelled, to 6 mm wide, acute to obtuse, margins with sparsely ciliate hyaline border. *Flowers* small, white with yellow throat; *perianth tube* 10–13 mm long; *tepals* 9–12 mm long, ovate, obtuse, ca. 4 mm at widest point. *Filaments* united, ca. 4 mm long; *anthers* ca. 1.5 mm long appressed to style and stigmas. *Style* dividing near base of anthers; *stigmas* fringed, becoming irregular, borne below apex of anthers.

Chromosome number: $2n = 18$.

Flowering time: July–September; flowers open 13h00, fade 15h30.

Distribution: local near the coast between Cape Agulhas and Saldanha Bay, usually in seasonally wet, sandy situations, often in shallow soil on rock outcrops (Fig. 12).

Galaxia albiflora is very inconspicuous even when in flower, and though little collected, it is probably fairly common throughout its range. It occurs only in seasonally wet situations along the coast from near Cape Agulhas to Saldanha Bay, and only in sandy soils. It is specialised in its reduced flower and very brief flowering time, 13h00 to 15h30. It is also autogamous, with pollen being shed directly on the stigmas. It thus appears as the end of a line of evolution which has resulted in morphological reduction and autogamy.

In the wild *Galaxia albiflora* is visited occasionally by small bees, and does hybridize with *G. fugacissima*, the only species that I have seen growing near it. Hybrids have been found only at Rondebosch Common, Cape Town, and are fairly numerous. This site is ecologically disturbed, with *G. albiflora* local in wetter sites and *G. fugacissima* mainly along trampled pathways and in open places, where it occurs in masses. The hybrid occurs mainly in open situations and is intermediate between the parental species in flower size, colour and leaf shape. Though pollen staining indicates barely reduced pollen viability, and both parents are diploid with $2n = 18$, the hybrids are completely sterile, and reproduce only vegetatively by producing cormlets. Reasons for the sterility are unknown.

It seems likely that *Galaxia albiflora* is of recent origin and perhaps evolved after the last interglacial, when sea level receded about 10 000 years ago. It occurs only near the coast, and generally between 10 and 30 m above sea level, though I have seen it on coastal hills up to 150 m high. Its autogamous reproduction would have enabled it to colonize newly available coastal habitats rapidly, as the sea retreated.

CAPE—3217 (Vredenburg): near Vredenburg (-DD), *Lewis 1140* (SAM), *Leighton 585* (BOL); Steenberg Cove, *Lewis 1049* (SAM).

—3318 (Cape Town): Langebaan (-AA), *Lewis s.n.* (BOL 20704); Oligants

Kop, Langebaan, *Goldblatt 2339* (MO, PRE, S, WAG); Posberg, Donkergat Peninsula, *Goldblatt s.n.* (MO); Rondebosch Common (-CD), *Isaac s.n.* (BOL), *Barker 4641* (BOL, NBG), *Goldblatt 2436* (MO, S); Blouberg, *Pillans s.n.* (BOL 18564); flats at Salt River, *Marloth s.n.* (PRE).

—3419 (Caledon): Ratelrivier, flats near Die Dam (-DA), *Esterhuysen 32019A* (BOL), *Goldblatt 2603* (K, MO, NBG).

INADEQUATELY KNOWN SPECIES

Galaxia sp. 1

Three collections from French Hoek Forest Reserve, *Salter 6891* (30 Aug., near Bushmans Castle) and *Isaac s.n.* (3 Oct.) and a third, *Compton 13875* (from Berg River Hoek, 4 Oct.), may represent an undescribed species. Vegetatively, they resemble *Galaxia versicolor*, but have pale yellow flowers, with small dark dots at the base of the tepals. The filaments are free in the upper 1 mm, and the anthers 2 mm long. Stigma details are not visible clearly but they seem to be entire. Perfectly pressed flowers or live material are needed for further analysis.

Galaxia sp. 2

A single collection from the Montagu district, at Eendracht (*Lewis 4746*) is impossible to identify. The flowers appear to have been yellow, and have apparently sessile anthers. Unfortunately the stigmas cannot be properly seen, but possibly emerge between the anthers, if so unique in the genus. The most likely determination is *G. citrina*, its nearest station being at Gydo Pass, a considerable distance from Eendracht. Live material is needed before the identity of the Eendracht plants can be evaluated.

EXCLUDED SPECIES

Galaxia multiflora Spreng. *Neue Entdeck. 1: 251. 1820.*

The description is inadequate for identification of this species in the absence of a type or authentic specimen. The species is probably *G. ovata*.

G. ixiaeflora [DC in] Red. = *Ixia monadelpha* de la Roche.

G. magellanica Steud. = *Tapeinia pumila* (Forst.f.) Baill.

G. minuta Ker = *Pauridia minuta* (L.f.) Dur. & Schinz. (Hypoxidaceae).

G. narcissoides (Cav.) Willd = *Phaeophleps biflora* (Thunb.) R. C. Foster.

G. obscura Cav. = *Ona obscura* (Cav.) Ravenna.

G. pedunculata Beg. = *Moraea falcifolia* Klatt.

G. plicata Jacq. = *Lapeirousia plicata* (Jacq.) Diels.

G. ramosa [DC in] Red. = *Ixia monadelpha* de la Roche.

ACKNOWLEDGEMENTS

This work was supported by grants from the United States National Science Foundation. I extend thanks to Professor T. T. Barnard for his advice and

assistance in the field and Margo Branch for the illustrations made under difficult conditions.

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